

## **Nomenclature and Cataloguing of Experimental Explosive Compositions**

Matthew D. Cliff and Richard M.  
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DSTO-TN-0284

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# Nomenclature and Cataloguing of Experimental Explosive Compositions

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DSTO-TN-0284

## ABSTRACT

This technical note describes the Australian Research explosive (ARX) nomenclature system and the supporting Propellant/Explosives Processing Sheet database used by DSTO to name and record experimental explosive compositions and their properties.

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*AQF00-12-3796*

*Published by*

*DSTO Aeronautical and Maritime Research Laboratory  
PO Box 4331  
Melbourne Victoria 3001 Australia*

*Telephone: (03) 9626 7000  
Fax: (03) 9626 7999  
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AR-011-471  
May 2000*

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# Nomenclature and Cataloguing of Experimental Explosive Compositions

## Executive Summary

Australia is becoming increasingly involved with the development and assessment of new explosive compositions to meet the Australian Defence Force's Insensitive Munitions and performance requirements. Up to this point, however, no procedure has been in place to systematically record the details of new R&D explosive formulations developed by DSTO.

This note describes the Australian Research eXplosive (ARX) nomenclature system which classifies experimental compositions, developed by DSTO, according to their binder type and/or processing method. The supporting Propellant/Explosives Processing Sheet (PEPS) database used to record ARX numbers, create formulation mixing instructions and record hazard and performance data is also described.

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# 1. Introduction

The 1990s have seen an increasing number of new explosive materials become available commercially which has given rise to a large number of experimental explosive compositions significantly different from traditional TNT and HTPB-based systems. At the same time, pressure continues to mount on Western nations to examine new explosive compositions that meet Insensitive Munitions criteria. Australia is not immune to these trends and is increasingly involved in the assessment of explosive compositions of foreign origin and in the development of new formulations to achieve performance and/or IM improvements over current systems. Up to this point, however, no procedure had been in place for the controlled recording of new explosive developments. The purpose of this note is to describe a nomenclature system used by DSTO that covers domestic developments, modification of overseas formulations for Australian purposes, and use of unaltered foreign formulations. The database used by Weapons Systems Division (WSD) of DSTO to record formulation details, mixing instructions and composition hazard and performance data, PEPS, is also described.

## 2. ARX Nomenclature System

### 2.1 Domestic Formulations

The Australian Research explosive (ARX) nomenclature system has been developed to cater for experimental PBX and melt-cast compositions under investigation. The system has been based upon well-established UK [1] and US [2] models (Appendix A), with experimental compositions classified by their binder type and/or processing method used.

The explosive composition is given the prefix ARX and allocated to one of the following classes.

ARX 1000 - 1999	Pressed Compositions
ARX 2000 - 2999	Inert Binder Compositions
ARX 3000 - 3999	Energetic Binder Compositions
ARX 4000 - 4999	TNT-Based and other Melt-Castables
ARX 5000 →	Yet to be Assigned

The assigned ARX number is used in conjunction with an M suffix to indicate minor composition modifications, such as the use of a different isocyanate or slight percentage increase in explosive content. Thus a new energetic binder composition containing HMX would be ARX - 3000/M1. Use of a different HMX grade would produce ARX - 3000/M2 and so on. A new ARX number is only assigned to a formulation when, in the opinion of the Scientist-in-Charge, the explosive's composition has been significantly modified from its original make-up. A change in the mix method does not warrant the assignment of a new ARX or modification number.

Compositions that utilise inert simulants to produce a High Explosive Substitute (HES) are designated using the suffix I. Thus a HTPB-based composition containing a simulant rather than, for example, RDX for training purposes would be designated ARX - 2000I/M1. If the formulation were to use a PolyGLYN binder then the designation would be ARX - 3000I/M1 and so on.

Renaming of ARX designated explosives once qualified for deployment in a weapon system has not been considered at this stage and will be the subject of a further technical note if required.

## 2.2 Foreign Formulations

Foreign formulations are to retain their national designation to indicate country of origin and aid data collection. 'Australianised' versions of a foreign PBX using, for example, different RDX types and classes retain their national designation followed by 'Aust' in parentheses to indicate modification for Australian requirements. A good example of this system is in the Australianised composition PBXW-115 (Aust). This composition uses locally manufactured Type I Woolwich RDX as the coarse RDX component, whereas the parent US composition uses Type II Bachmann RDX which contains 5-12% HMX as a synthetic byproduct.

## 3. PEPS Database

The Propellant/Explosives Processing Sheet (PEPS) database incorporates the ability to;

- a) create and record a new ARX number for all formulation types,
- b) record hazard, stability, physical and performance data for a composition/material,
- c) create a processing mix sheet for an explosive formulation,
- d) store all previous mix sheets.

Additionally, the PEPS database has the ability to search for data and past mix sheets for specific compositions by formulation type, originator, date and Work Allocation (WA) number. The database is stored within the Explosives Group sub-directory. A flow-chart overview of the database is given in Appendix B.

### 3.1 Assigning an ARX Number

The following procedure should be followed to create a new ARX number using PEPS.

- a) From the *Main Menu* select 'ARX Numbers' and then 'New ARX Number'.

- b) Select the type of binder system to be used in the formulation. Enter Originator, Date and Formulation details, the ARX number will be automatically generated and stored.
- c) Previously used ARX numbers can be selected using 'View ARX Numbers' if the requestor is unsure whether the formulation has been previously made. If any blank records are found in the category required, the experimentalist should use this number and fill in the required fields rather than create a new number.

Once a formulation has been optimised and no further modifications required, the experimentalist should enter the *View ARX Numbers* menu, select the formulation category used and update the formulation description to reflect the final composition used and its modification. These fields *must* be kept current.

### 3.2 Creating a PEPS

- a) From the *Main Menu* select 'PEPS'.
- b) Select 'Add Material' and 'Add Specification' to add new materials (RDX, PolyGLYN, etc) and specifications (Grade A, etc) to the database as necessary.
- c) Select 'View PEPS' and then 'New Sheet' to create a blank mix sheet. The mix number will be automatically assigned. Alternatively, select 'Copy Current Record' from a similar formulation's PEPS. This will create a new sheet containing the previous mix details, which can then be altered.
- d) Add into the mix sheet the composition, operator and task details plus the total mass of the mix. Use the pull-down menus to add formulation ingredients and their specifications. Add in the relevant percentage for each ingredient (the accompanying masses will be automatically generated).
- e) Add in the mix procedure, pot temperature and casting/curing requirements as necessary. The PEPS sheet is automatically saved.
- f) Select 'Show Mix Sheet' to obtain a preview of a working mix sheet and then print to obtain a copy for use in the laboratory (Appendix C).
- g) Once a mix has been completed, the PEPS can be re-entered to record any post-mix comments and observations as necessary.

To find a previous mix sheet, select 'Open Search Engine' from *PEPS Database*. The search engine will allow you to locate a specific file by viewing Formulation Type, Date, WA Number or the Originator of the mix sheet.

### 3.3 Hazard and Performance Data Storage.

Hazard, stability and performance data once obtained should be entered into the PEPS. The experimentalist should liaise with the original Scientist-in-Charge if follow-up work is being carried out on a formulation to ensure consistency of recordings.

- a) From the *Main Menu* select 'Properties Database' and then 'Add New Record'.



- b) Enter Sample ID (*ie* ARX-2000/M2) and Requestor details, and complete the required fields (Sensitiveness Data, Physical and Performance Data, VoD and Detonation Pressure, and Thermal Data).
- c) To update a previous record, select 'Search Database' and select the record to be updated.
- d) Add in additional data to the record. New data is automatically stored.

To search the database for a current record select 'Search Database' from the *Properties Database* menu, a listing of all entries will appear. The report can then be printed to obtain a hard copy.

## 4. Conclusion

This technical note describes a nomenclature system and supporting database to name and catalogue explosive formulation developments, and hazard and performance data. The procedure is designed to allow all formulation types to be catalogued along with the recording of relevant properties. The Explosives Group in Weapons System Division, will retain maintenance and control of the system.

## 5. References

1. Weapons System Sector, DRA (1996)  
*Recording Developments of New Explosive Compositions within EPF*, DRA/WSS/WX4/DP/008/1, Defence Research Agency Work Instruction, Fort Halstead, UK.
2. Hall, T. N. and Holden, J. R. (1988)  
*Navy Explosives Handbook. Explosive Effects and Properties Part III. Properties of Explosives and Explosive Compositions*. NSWC MP 88-116, Naval Surface Warfare Centre, USA.

## Appendix A: UK/US Formulation Nomenclature

### A.1. United Kingdom Nomenclature, DERA Fort Halstead.

PBX compositions are recorded and classified according to the type of binder used, except for booster compositions and those containing ammonium perchlorate (AP). The composition is given the prefix CPX (Composite Polymer eXplosive) and one of the following classes used:

CPX 1 - 99	Booster compositions
CPX 100 - 199	AP-based compositions
CPX 200 - 299	Polyester and polyether based compositions
CPX 300 - 399	HTPB-based compositions
CPX 400 - 499	Energetic binder compositions
CPX 500 - 599	Thermoplastics, including pressable compositions
CPX 600 →	Yet to be assigned

These composition numbers are used in conjunction with an **M** suffix for indicating minor composition variations. Inert compositions are designated using the suffix **I**.

### A.2. United States Navy Nomenclature, Naval Surface Warfare Centre.

Navy formulations are identified according to how the composition is loaded and allocated into the following classes:

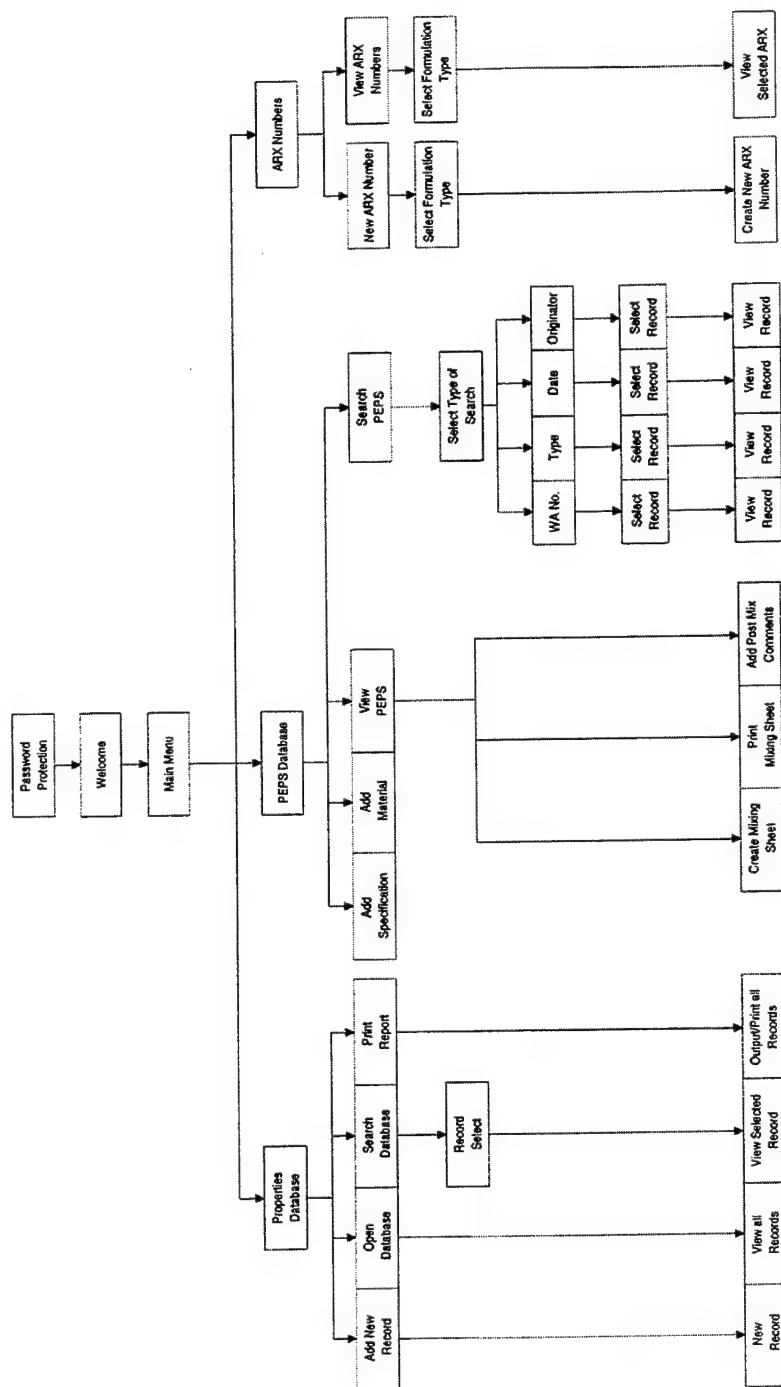
PBX 1 - 99	Pressed compositions
PBX 100 - 199	Cast compositions
PBX 200 - 299	Extruded compositions
PBX 300 - 399	Injection moulded compositions

The acronym 'PBX' is followed a further abbreviation (eg PBXN) to identify where the composition was developed or whether it is type qualified.

W	White Oak (ceased 1996)
C	China Lake
IH	Indian Head
Q	Qualified for weapon development
E	EAD program modification
N	Type qualified in US navy weapon

Once type qualified, the original designation is discarded and a new number assigned (ie PBXW-115 was reallocated to PBXN-111 once qualification testing was completed).

## Appendix B: PEPS Database Overview



# Appendix C: PEPS PBX Mix Sheet

## Propellant/Explosives Processing Sheet

WA Number 001191 Type ARX-2002/M4 Weight of mix 3500  
 Originator Watt Extension 95105 Mix Number EG 0054 Date 29/09/1999  
 Mixer 1 gallon Composition RDX/Al/HTPB/IPDI Cast No 0002

MATERIAL	%	IDENTIFICATION	WEIGHT(g)
HTPB	8.50	R45HT Elt Atochem (degassed +0.88% AO)	297.500
IDP	9.5	Isodecyl pelargonate	332.500
Al	20	Comalco Cap 45A Batch 062	700.000
RDX (Coarse)	61	Class A	2135.000
IPDI	1	Isophorone Diisocyanate	35.000
D-22	0.01		0.350
	0		0.000
	0		0.000
	0		0.000
	0		0.000
	0		0.000
Total Percentage:	100.01	Total Weight:	3500.350

Formulation note

MIX PROCEDURE AT 45 degrees C

Step	Action	Speed	Time no vacuum	Time vacuum
1	HTPB, IDP (standard with AO&D-22)	40	5	15
2	Al added in 3 lots with same mixing blwn	40	5	15
3	Scrape Down			
4	RDX (half)	40	5	15
5	RDX (half)	40	5	15
6	Scrap down			
7	Add IDPI	40	5	10
8	Scrap down			
9	Mix	40	0	20
10				
11				
12				
13				
14				

### CASTING AND CURING REQUIREMENTS

Casting	No.	Vac/Press	Vib.	Cure time	Cure temp	Cast time	Vac time	Vacuum (torr)	In Oven	Out Oven	Oven No.
25*300mm	3	Vacuum	<input checked="" type="checkbox"/>		45						
VoD tubes			<input type="checkbox"/>								
			<input type="checkbox"/>								

Comments

Operators DW, RD, AS, JS

## Explosives Group

## PEPS Processing Ingredients/ Weighing Check Sheet

Mix Number: EG 0054

Weighed by:

Date: 29/09/1999

Checked by:

Cast No: 0002

Ingredient	Balance	Weights (g)
HTPB		Ingredient Wt: 297.50 Tare: Total Wt: Wt after addition:
IDP		Ingredient Wt: 332.50 Tare: Total Wt: Wt after addition:
AI		Ingredient Wt: 700.00 Tare: Total Wt: Wt after addition:
RDX (Coarse)		Ingredient Wt: 2135.00 Tare: Total Wt: Wt after addition:
IPDI		Ingredient Wt: 35.00 Tare: Total Wt: Wt after addition:
D-22		Ingredient Wt: 0.35 Tare: Total Wt: Wt after addition:
		Ingredient Wt: 0.00 Tare: Total Wt: Wt after addition:
		Ingredient Wt: 0.00 Tare: Total Wt: Wt after addition:
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2. TITLE  Nomenclature and Cataloguing of Experimental Explosive Compositions			3. SECURITY CLASSIFICATION (FOR UNCLASSIFIED REPORTS THAT ARE LIMITED RELEASE USE (L) NEXT TO DOCUMENT CLASSIFICATION)  <div style="display: flex; justify-content: space-between;"> <span>Document</span> <span>U</span> </div> <div style="display: flex; justify-content: space-between;"> <span>Title</span> <span>U</span> </div> <div style="display: flex; justify-content: space-between;"> <span>Abstract</span> <span>U</span> </div>		
4. AUTHOR(S)  Matthew D. Cliff and Richard M. Dexter			5. CORPORATE AUTHOR  Aeronautical and Maritime Research Laboratory PO Box 4331 Melbourne Vic 3001 Australia		
6a. DSTO NUMBER DSTO-TN-0284		6b. AR NUMBER AR-011-471		7. DOCUMENT DATE May 2000	
8. FILE NUMBER J 9505-19-47		9. TASK NUMBER JNT 98/045		10. TASK SPONSOR JALO	
11. NO. OF PAGES 13		12. NO. OF REFERENCES 2		13. URL OF ELECTRONIC VERSION ON THE WORLDWIDE WEB  <a href="http://www.dsto.defence.gov.au/corporate/reports/DSTO-TN-0284.pdf">http://www.dsto.defence.gov.au/corporate/reports/DSTO-TN-0284.pdf</a>	
14. RELEASE AUTHORITY  Chief, Weapons Systems Division		15. SECONDARY RELEASE STATEMENT OF THIS DOCUMENT  <p style="text-align: center;"><i>Approved for public release</i></p>			
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16. DELIBERATE ANNOUNCEMENT  No Limitations					
17. CASUAL ANNOUNCEMENT <div style="text-align: right;">Yes</div>					
18. DEFTTEST DESCRIPTORS  Nomenclature, explosives, formulations, compositions.					
19. ABSTRACT This technical note describes the <u>A</u> ustralian <u>R</u> esearch <u>e</u> Xplosive (ARX) nomenclature system and the supporting Propellant/Explosives Processing Sheet database used by DSTO to name and record experimental explosive compositions and their properties.					